Chemical Alternatives to Methyl Bromide for Strawberry Production in North Carolina

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Methyl bromide-dependent plasticulture production of strawberries is an important component of income for small to midsize farms in North Carolina. This system consists of plastic mulch, drip fertigation, and soil pest-management treatment. This system is like a three-legged stool and the phase out of a major soil pest-management treatment, namely methyl bromide (MB), threatens the current profitability of strawberry enterprises. MB is an integral part of the small-scale farmer's plasticulture tool box for growing profitable crops of strawberries (Poling and Monks, 1994). The expected economic impact is difficult to measure because there is no simple exchange of an alternative compound for methyl bromide. Changes in cultural systems or using alternative fumigants will require changes in management practices and scheduling of activities. Likewise, adopting alternative practices may impact pest populations and result in a shift of predominant or important pathogens, insects, or weeds.

In 1997 we initiated four field trials in different regions of NC (Coastal, Piedmont, Mountains) to explore alternative products or alternative farming systems to minimize risk of decreased profits with the pending loss of methyl bromide as a soil fumigant (Louws et al., 1998a, 1998b). We also have initiated work to better understand the community of pathogens associated with strawberry root disease incidence. In this report we highlight results from one trial and preliminarily report on fungal pathogens associated with strawberry roots.

A field trial was initiated on land with no recent history of strawberry production and in the coastal production region near Plymouth, NC. Seven treatments arranged in a RCBD with 4 replications were installed in 1997 including: 1) no treatment, 2) methyl bromide [98:2 at 200 lbs/acre in row], 3) Telone-C35 [14 gallons/acre in row], 4) Vapam HL [37.5 gallons/acre in row], 5) solarization [Jul-Aug], 6) solarization plus cabbage residue [8 T/acre], and 7) methyl bromide (1997) then compost [30 yd^3/acre] thereafter (1998-1999). (Compost-based plots were managed in a manner similar to protocols detailed in another article in these proceedings). Plots were 3 beds wide and 30 feet long and planted to twin rows of Chandler plug plants spaced 14 in. apart. Whole plant samples were collected monthly and leaf area, crown number, percent root lesion incidence, and plant dry weights (root, crown, leaf, flower and fruit) were measured. Yield and fruit quality data were collected from the center bed in each plot beginning in early April to mid-June. All treatments were applied to the same plots for three years (i.e. there was no crop rotation).

Growth parameter data are not reported here. Table 1 highlights total yield, marketable yield and average berry weight. Table 2 highlights the relative yields expressed as a percentage of those obtained in MB treated plots. In Year 1, total and marketable yield values were not significantly different in all treatments, although yields were numerically lowest in the control plots. The solarized, T-C35 and Vapam plots all had larger average berry size than the control and MB treated plots. Compost was not included in the first year, rather, this plot was fumigated with MB.

In the second year, yield in the solarized plots and the (first year) compost plots were low and this yield decline continued in Year 3 in the solarization-based plots. In contrast, the compost-based plots were similar to the MB-treated plots after the second year of compost application. Vapam treated plots generated consistent yields throughout all 3 years. The Telone C-35 plots demonstrated a tendency to decline in Year 2; in Year 3 phytotoxicity was observed on strawberry plants soon after transplanting. In Year 3, the Plymouth region was subject to 2 hurricanes during the fall of 1999 and excess moisture delayed proper scheduling of fumigant applications, compressed waiting periods for planting after fumigation, and a delay in field setting plants beyond the optimum date for this region. These factors resulted in substantial reductions in total yield and the phytotoxicity observed in the Telone C-35 plots.

The weather challenges highlighted the limited tolerance NC production systems have for extended waiting periods for plant-back. Fall weather conditions are often variable and some of the alternative fumigants offer less management flexibility. This was not a concern in the compost plots nor solarization plots. However, there was a steady decline in productivity in the solarized plots over the 3-yr time frame.

In our preliminary studies with strawberries we obtained 300 fungal isolates in four localities in North Carolina during the spring of 1998, 1999 (isolations from 2000 are not summarized). These fungi appear to be associated with the black root rot (BRR) complex. *Rhizoctonia fragariae* AG-A, AG-G, AG-I, *Pythium artotrogus*, *P. irregulare*, *P. paroecandrum*, *P. ultimum*, Pythium “F’, *Pythium* “HS*”*, *Fusarium solani, F. oxysporum, F. acuminatum, F. equiseti*, *Cylindrocarpon destructans, Cephalosporium* sp., *Gliocladium* sp., *Macrophomina* sp., *Phoma* sp., *Pyrenochaeta* sp., *Thielaviopsis basicola*, and *Trichoderma* sp. *R.fragariae* AG-A and *P. irregulare* were the most predominant organisms found associated with the disease. The predominance of *R. fragariae* AG-A over AG-G and AG-I types was also observed in Connecticut (Martin, 1988). Our results are consistent with other reports of Black root rot published in Italy (Ciccarese and Cerulli, 1983), and Japan (Watanabe, 1977). *R. solani* AG5 was reported isolated from strawberry roots in Connecticut (Martin, 1988). Pathogenicity was demonstrated for a select number of isolates. The diversity of organisms associated with strawberry roots underscores the complex nature of the Black root rot disease. The survey and characterization of fungal pathogens associated with the strawberry roots at the different sites provides a framework to better understand yield limiting root diseases and provides insight into possible management strategies to limit yield decline.

Table 1: Total and marketable yields from harvest seasons 1998-2000 at Plymouth, NC.

	Total yield (lbs/acre)			**Marketable yield (lbs/acre)**			**Berry wt (g/berry)**		
Treatment	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**
Compost		14960	12854		13260	10628		15.6	20.2
control	21185	16490	9690	17731	16150	7916	15.5	15.8	18.5
MB	27172	23290	12450	22029	22270	10368	15.4	15.7	19.6
Sol/cab	25673	14960	6441	22336	14110	5338	16.9	13.8	15
Sol	25215	15810	5282	22336	14790	3975	17.1	14.3	17.4
TC35	29590	19720	3791	23373	18530	2841	17	14.8	14
Vapam	29705	24310	13492	24524	23290	10870	17	15.3	22
LSD	ns	7990	3698	ns	801	4636	1.3	ns	4.6

Table 2: Yields expressed as a percentage relative to those obtained in MB treated plots.									
	Relative total yield			Relative marketable yield			Relative berry wt		
Treatment	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**
Compost		64	103		60	103		99	103
control	78	71	78	80	73	76	101	101	94
MB	100	100	100	100	100	100	100	100	100
Sol/cab	94	64	52	101	63	51	110	88	77
Sol	93	68	42	101	66	38	111	91	89
TC35	109	85	30	106	83	27	110	94	71
Vapam	109	104	108	111	105	105	110	97	112

References:

Ciccarese, F. and Cerulli, M. 1983. Osservazioni sui deperimenti dei fragoleti nell' Italia meridionale. Informatore Fitopatologico 9: 52-62.

Louws, F.L., G.E. Fernandez and M. Grabowski. 1998a. Compost as a means of nutrient management in strawberry production. EPA Methyl Bomide Alternatives Conf. Proc. http://www.epa.gov/ozone/mbr/mbrpro98.html

Louws, F. G. Fernandez, G. Miner, D. Monks, E. Bish, B. Poling and K. Sorensen. 1998b. Methyl bromide alternatives research for strawberry production in North Carolina. EPA Methyl Bomide Alternatives Conf. Proc. http://www.epa.gov/ozone/mbr/mbrpro98.html

Martin, S.B. 1988. Identification, isolation, frequency, and pathogenicity of anastomosis groups of binucleate *Rhizoctonia* spp. from strawberry roots. Phytopathology 78: 379-384.

Poling, E.B. and D.W. Monks. 1994. Strawberry plasticulture guide for North Carolina. North Carolina Agr. Ext. Ser., Bulletin AG-515, 16 pp

Watanabe, T. 1977. Fungi associated with strawberry roots in Japan. Trans. Mycol. Soc. Japan 18; 251-256.